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Information Display

Journal of the Society for Information Display

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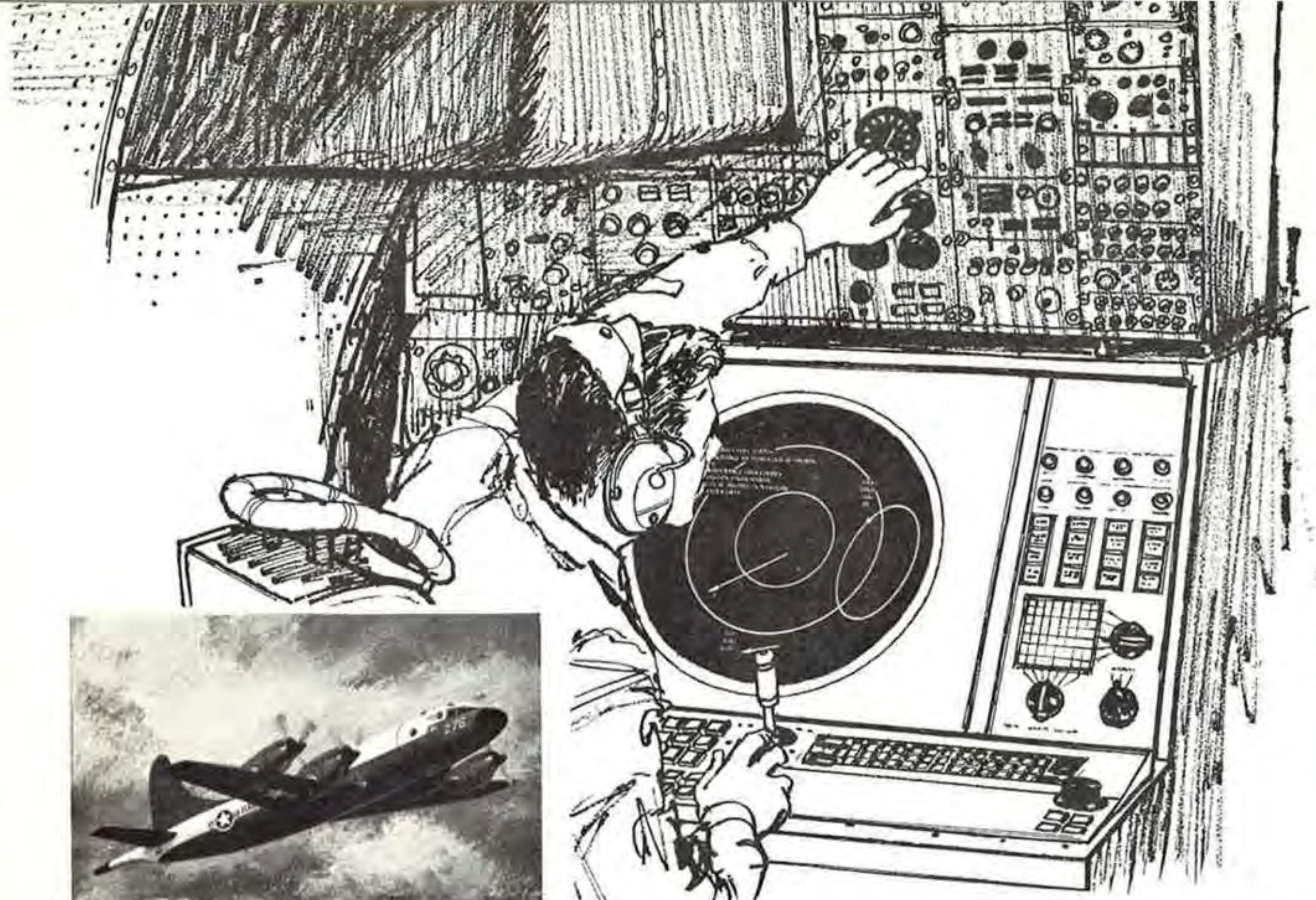

New airborne computer display allows immediate analysis of tactical situations

The most comprehensive situation display ever provided a pilot and crew of an aircraft has been developed for the U.S. Navy's A-New program, a project of the Naval Air Development Center, Johnsville, Pa. General Dynamics developed the airborne display console which operates with the Navy's new airborne digital computer system being developed for anti-submarine warfare. The display takes commands from the computer which considers all data received from the electronic sub-hunting equipment, communications links and other sources.

Information which may be visually presented to the airborne tactical coordinator includes text and tabular data on such factors as tactical and navigational problems. Situation maps showing locations of possible targets and other ships and planes in the area may be presented.

Using the CHARACTRON® Shaped Beam Tube, the versatile display presents high resolution alphanumerics by extruding an electron beam through a matrix etched with characters and symbols. Vectors are drawn with a spot writing mode. This data may be mixed with information recorded on a scan converter tube or other electrical storage device. Externally generated figures may be displayed using the electron beam on a time shared basis. Advanced versions will be able to combine live TV and radar data with alphanumerics and vectors generated by the computer.

Initial display equipment is a compact rugged version of the S-C 1090 standard display console which is capable of operating in the high vibration environment of an aircraft flying either at high altitude or close to the water. To adapt the console to airborne use, a special CHARACTRON display tube was developed which is only 27½ inches long, compared to a standard 42 inches. Innovations in tube design reduce the length and create remarkably high resolution for display applications where space is at a premium.

Present system developments include seven displays in varying sizes for presentation of data to various ASW aircraft crew members. Several of these displays will be portable and interchangeable. These displays are another *operating* example of Stromberg-Carlson's capability to supply reliable answers to display problems.

For more information on advanced displays, write Stromberg-Carlson–San Diego, Dept. E-59, P. O. Box 127, San Diego, Calif. 92112.

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VOL. 1, NO. 2 NOV./DEC., 1964

Information Display

Journal of the Society for Information Display

ARTICLES

Voice-Response and Visual-Display Techniques for On-Line Information-Handling Systems

by Emik A. Avakian and F. Walter Jenison ....Page 12

Psychological throughput is maximized via current voice-response systems and visual-display devices developed by Bunker-Ramo Corporation's Teleregister division for the American Stock Exchange.

The JPL Space Flight Operations Facility Display and Control System

by Albert S. Goldstein ....Page 20

Present Experience and Future Requirements. A review of the SFOF display subsystem, as presently constituted, and anticipated techniques and devices suitable for automated operations, as disclosed in a recent survey of long-term needs.

Display Requirements of the Integrated Management Information System, 1968-70

by Peter James and Donald L. Dittberner....................Page 26

Within five years, virtually every large integrated management information system will have many displays associated with it, thereby providing one of the few tools helpful to the highest levels of management.

DEPARTMENTS

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The tree on the CRT, as artist Howard Goldstein portrays it, is the tree of knowledge with its fruit on a readily accessible branch ripe for plucking, perhaps as ripe as the field of information display itself.

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ID Readout

Chapter News

LOS ANGELES CHAPTER: Eighty-seven members and guests in a joint meeting with the San Diego chapter, hosted by the Air Force, made an inspection tour of SACCS (465L). New officers of the Los Angeles chapter are L. M. Seeberger, chairman; Dr. R. E. Bernberg, vice-chairman; J. Belcher, secretary; W. S. Miller, treasurer; and R. Davidson, R. Kuehn and P. Vlahos, executive council. First fall season meeting was at the NBC studios in Burbank for a technical tour of facilities. Floyd Smoller, chapter membership chairman has begun a drive to increase local membership and has membership packets available. MID-ATLANTIC CHAPTER: Theme of this year's bi-monthly discussions, established during the October meeting, will be transition of information display technology from military to civilian environment. H. Colman Rosenberg, for 10 years systems engineer on SAGE and Project 465L or SAC, discussed "Systems: Yesterday – Today – Tomorrow". Officers for 1965 are Carl Machover, chairman; Robert C. Klein, vice president; Leo Beiser, treasurer; Dr. Edith Bairdain, secretary. Closing meeting for the year was addressed by Howard G. Kurtz, management consultant and proponent of War Control Planners, Inc., to prevent war by an international electronic control system. WASHINGTON, D.C.: Approximately 500 registrants were present for the Fourth National Symposium at Washington's Shoreham Hotel. Highlights included the keynote address by Col. Daniel C. Bird, US Army, the banquet address by Richard Shetler of GE, and presentation of awards jointly to H. N. Oppenheimer, Aerospace Div. General Precision Inc., and Daniel J. Morrison, US Navy. Recent meetings have included a tour of the AFSC Command Management Center, and a discussion of display usage for management purposes, by Milton Ennault, Goddard Space Flight Center. New officers for 1965 are Ernest N. Storrs, chairman, and William C. Roberson, corresponding secretary.

GP/Link Waveform Display/Analyzer

The U.S. Air Force Ballistic Systems Div. has awarded a $300,000 contract to General Precision's Link Group for design and fabrication of a device to analyze re-entry photography, Lloyd L. Kelly, Link pres., has announced. The device, a waveform display/analyzer, is a digital computer driven film scanning and input/output driven display system. It will accept spectographic, densitometric and waveform photography data, perform initial scanning operations and digitize the data for introduction into a digital computer complex where numerical analysis of the film phenomena is made.

LTV's New ABCCC Under Evaluation

The Tactical Air Command is evaluating a recently-delivered Airborne Battlefield Command and Control Center (ABCCC) produced by LTV Temco Aerosystems Div. on a $2.4 million contract. A virtual airborne war room, it was designed and built from scratch in 98 days. It can function as a joint operations center, tactical air control center, Army operations center, direct air support center, or as an emergency air-strike control center. Air Force Tests at Eglin AFB are designed to prove that direct reconnaissance transmissions could give the joint task force commander and/or his air and ground component commanders and assistants a continuous real-time picture of the enemy in war-conditions. A semi-automatic system is designed to display, visually, varied and vital data, including "both-sides" air and ground order of battle, weather conditions far and near, and pre-planned missions awaiting execution. A "total communications net" places the commander in contact with all echelons such as TAC centers, Army command posts, ships at sea, tactical fighters, assault transports, reconnaissance planes and helicopters.

On-Line Computing Systems Symposium

Jackson W. Granholm, VP/Technical Communications, Informatics, Inc., and Dr. Sam M. Houston, UCLA, have announced a symposium of on-line computing systems Feb. 2-4 at Schoenberg Hall on the UCLA campus, under joint sponsorship of Informatics and UCLA. Papers are to be presented by top experts in the several disciplines of on-line systems. Dr. Ivan Sutherland, ARPA's director of information processing techniques, will make the keynote address, and the banquet address will be delivered by Dr. Simon Ramo, pres., Bunker-Ramo Corp. Presentations will cover system characteristics, current and future applications, and requirements for software, communications, and display. Discussion will center on systems which preclude manual intervention (process control, radar tracking and recording, etc.) and which incorporate man/machine interface devices (military command and control, and various commercial systems). Information can be obtained through UCLA Engrg. Extension (Tel. 213 GRanite 8-9711, station 3721), California 90024.

Tritium-Activated Luminous Light Sources

Conrad Precision Industries, Inc., has introduced a new line of self-luminous compounds and light sources that employ Tritium as the activator, eliminating gamma and alpha emission, and decreasing bremsstrahlung radiation. All beta radiation can be absorbed by either a glass or plastic coating.

Marquardt Acquires Automation Labs

The Marquardt Corp. will acquire the assets of Automation Laboratories, Inc. on a stock-transfer arrangement, and will maintain the operation as a wholly-owned subsidiary, according to Roy E. Marquardt, pres. The acquisition is the first East Coast facility of Marquardt.

Analog Display Oscilloscope

A new analog display oscilloscope which permits a visual presentation of electrical variations in the form of readout information has been announced by Nuclear Data, Inc. The new oscilloscope provides circuitry for vertical or horizontal positioning and gain, and for waveform definition. Solid state circuitry is used throughout and a 3000-v electron-beam accelerator potential is employed for distinct image presentation on the 5-in. CRT screen.

IBM Graphic Data Processing System

IBM's new graphic data processing system offers unusual capabilities in computer-aided design, development of engineering drawings, or preparation of statistical business graphs under computer control. The system includes IBM's 2250 display, 2280 film recorder, 2281 film scanner, and 2282 film recorder/scanner. Each unit can be used independently. They are linked to a System/360 processor through a 2840 display control unit which provides buffer control and character generation. The 2250 display can utilize an electronic light pen to modify or update displayed images called from computer storage or microfilm, and original drawings can be composed on the 2250 with its program function keyboard. The 2280 film recorder records images on unsprocketed 35-mm film; processed images can be magnified 19 times for viewing on the 2280 rear-projection screen. Character generation features enable the 2280 to record on film 63 different alphabetic and numeric characters and symbols in three different sizes at 40,000 cps. A 1.2-in.-square image consists of up to 150 lines, each containing up to 204 characters.

GD/Stromberg-Carlson Awarded ASW Contract

Stromberg-Carlson Div. of General Dynamics has been awarded a $400,000 contract for special airborne ASW computer-display equipment by Naval Air Development Center, Johnsville. NADC's ASW lab will use the equipment to develop new ASW techniques. The mission commander and ASW system operators will be able to select and display only the information needed at any moment. Display is by Charactron (Reg.) shaped-beam tube, in form of characters and vectors in combination with analog information at speeds up to 60,000 cps. The Div. also announced recently the development of a system which records computer-generated data directly on microfilm at 62,500 characters/sec., or at least 50,000 filmed documents in a single 8-hr. shift.

Fairchild/DuMont Fast-Writing Tubes

Fairchild's DuMont Laboratories has announced new fast-writing tubes utilizing fiber-optic face plates. They feature extremely high deflection sensitivity, high resolution electrostatic focus and deflection cathode-ray tubes, enabling low-level, fast-transient information, directly coupled to signal plates, to be contact-printed in sharp detail through the fiber optic face plates. Type K2427 is capable of writing speed of 10^{12} trade widths/sec. at overall acceleration potential of 10 kv. Characteristics include resolution of 500 trace widths/in. and deflection factors of 3 and 10 v/cm. in the signal and time axis, respectively. Type K2448 achieves further gains in deflection sensitivity with factors of 1 and 7 v/cm. in the signal and time axis. Resolution is 165 trace widths/in. with a useful non-defocusing scan of 350 and 450 trace widths in the signal and time axis, respectively.

Five New Westinghouse Tubes Announced

Westinghouse Electronic Tube Div. has recently announced five new tubes of interest in display. Included are two CRTs with fiber-optic faceplates: WX-30038 has a usable diameter of 3.2 in., utilizing magnetic deflection and electrostatic focusing; WX-5321, designed for line scanning, has a band of optical fibers across the center of the faceplate with usable length of 4¼ in. and width of ⅛ in. Others are WX-5320, electrical-in electrical-out electronic storage tube; WX-30046, for radar systems ,8.5-9.6 gc), a high-gain broad-band TWT for PPM; and WX-30154, electrostatically deflected and focused display storage tube featuring construction and a single writing gun.

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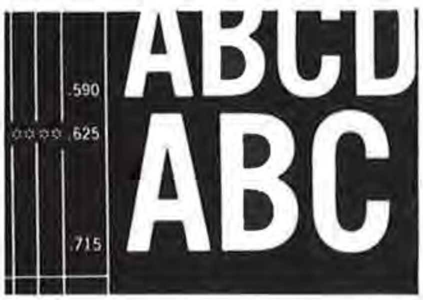
SOME COMMON SENSE OBSERVATIONS ON READABILITY OF READOUTS

WHAT GOOD IS A READOUT THAT'S SEEN BUT NOT READ?

That may seem like an odd question, yet daily we're finding examples of readouts that provide far less than the best in readability. Yet, what's a readout for, if not readability of the highest order? The whole purpose of readouts is translation of electrically transmitted information into easy-to-read messages.

This cut-away of a typical IEE readout will give you some idea how the device operates to provide optimum readability:

First, the presentation is single plane: only the message that's "on" is visible. What's even more important, the message is projected from a film. Hence, an IEE readout can display anything that can be put on film, including numbers, letters, words, even colors and symbols. Thanks to this display versatility, you can order your IEE readouts with a character style that has been proved by human factors engineers as being most legible to the average reader. A section from our sample type sheet gives an example of a commonly used type style. Since these readouts can display anything that's photographically reproducible, any type style may be used. This enables us to meet every military and human engineering specification known.



Compare these big, bold characters with the segmented characters used for most electro-luminescent and incandescent bar segment readouts. These readouts contain a matrix made up of a number of segments with selected ones lighted to make up the display. As a sample, the next sentence is composed of these characters, photographically reproduced here without any change:

SPEED AND ACCURACY OF READING DROPS BECAUSE ALL OF THESE CHARACTERS ARE SIMILAR

There's another serious problem with this type of readout. Suppose that the reading calls for a figure 8 . If a specific segment fails, the indication will show 6 . Or, if a different segment fails, the figure 8 could show up as 9 —project this situation to a digital altimeter in an aircraft. Then hope that the difference between say a reading of 9,000 feet and an actual 8,000 doesn't involve contact with a mountain peak! We can only conclude that a readout should be seen but not mis-read.

THE BC RATIO FOR READABILITY

B is for Brightness, C is for Contrast—the two work together to give you a crisp, highly legible message. One won't do without the other, and in proper ratio at that. Consider the gas ionization readout with its glowing filaments: you get plenty of brightness but where is the contrast? But let's take them one at a time:

BRIGHTNESS

This is a reasonable facsimile of how character brightness affects readability despite a constant strong background contrast. IEE readouts offer up to 90 foot lamberts of brightness. But brightness can't be the sole basis for measuring readability...

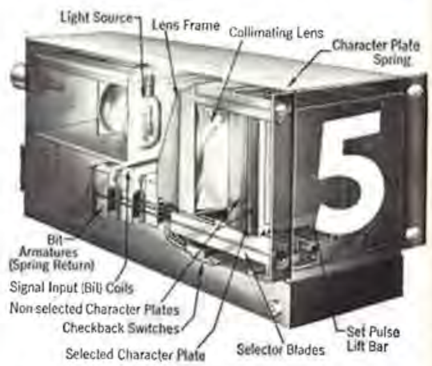
CONTRAST

Here we've kept the character brightness constant but varied the background until we achieve proper contrast at far right. It's quite obvious—brightness without contrast doesn't do much for readability. IEE readouts provide the proper ratio of brightness and contrast for visual crispness and unmistakable clarity at wide angles, long viewing distances, even under adverse high ambient light conditions. In short, IEE readouts are the most readable readouts made. That's part of the reason we're so partial to them.

PULSE CODE RECEIVER BY VAREC, INC.
Subsidiary of Microdot Inc.
VISUAL TRANSLATION BY IEE

The Varec/Dynel Pulse Code Receiver decodes and displays liquid level, pressure, flow rate, and temperature data gathered from remote locations by their high speed telemetering system. Giants of the chemical, petroleum, and food processing industries have installed this system for continuous control over things that bear some watching. To make sure that the watching is highly watchable, Varec engineers specified the most readable readouts made. We made the readouts.

THIS IEE READOUT DECODES, DISPLAYS, REMEMBERS



IEE Bina-View® is a binary input, self-decoding readout with a complete alpha-numeric capability. Decoding is entirely self-contained; no external translators, relays or diodes are required.

Its 41-message capacity permits additional display of colors, symbols, words. Floating decimal points are available from a separate lamp circuit.

Bina-View also provides automatic memory and retains the last message displayed after signal and set-pulse power have been removed. As an optional feature, Bina-View may also include auxiliary contact closures that can be used for check-back to verify input signals and to transmit input signals back into source equipment.

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EDITORIAL

SID JOURNAL OFFERS WORTHY OPPORTUNITY TO AUTHORS IN FIELD

Only a year and a few months ago a four page publication, the "SID Readout," made its first appearance replacing a less formal newsletter that originated in January 1963. With the inauguration of *Information Display* the cogent and diverse scientific and engineering disciplines are offered a common medium for technical exchange. Augmented by the Technical Session Proceedings of the semi-annual Symposia on Information Display, the new *SID* journal truly recognizes for the first time the *de facto* existence of display science and engineering as a field unto itself.

Historically, the literature has grown first from the works of specialists, followed by the broader vistas of the generalists. The present scope of both display systems and display devices embraces electronics, psychology, physics, physiology, photography and mechanical design, not to mention a host of subdivisions such as optics, human factors, psycho-physics, and many others. In dealing with any interdisciplinary field one inevitably encounters semantic and definitional problems. How many recall and how many have yet to encounter for the first time the puzzling, yet simply explained, difference between optical and television lines of resolution! Today's hyphenated sciences only begin to portend tomorrow's re-combinations of phenomenologically convenient groups into the larger complexities which are truly the world around us.

So must the electro-opticisist, the electro-physiologist, the bio-physicist, the Boolean logician, and whoever else is concerned, delineate and communicate his results and interests to the others in pursuit of the common goal — in this case, the furtherance of display science and technology. The vehicle is *Information Display*. The method is the original technical paper. The procedure is simply obtained and equally simple to follow. A letter to the editor will bring an immediate answer. Alternatively, submit a 500 word summary in duplicate of material proposed for publication. The opportunity to contribute to the literature of displays in an identifiable form is here. How many will be the authors to make their contributions now — and in future years look back with pride upon the significance of their early published works?

R. L. KUEHN
Publications Chairman, SID

As one of the founders of the Society for Information Display, Rudolph L. Kuehn has served as protem Vice-President, President, 1964 Nominating Committee Chairman, Fifth National Symposium Papers Chairman and is currently Chairman of Publications.

He is presently with the Control Nucleonics Division of Giannini Controls Corporation as Manager of Design Engineering. He was with the Aeronutronic Division of Philco Corporation for six years during which time he was Manager, Display Systems Department.

During the past seventeen years he has also held positions as Television Project Officer at Wright Air Development Center, Assistant Engineering Manager at the Ralph M. Parsons Company, and various assignments with the National Broadcasting Company, Hycon Mfg. Company and others.

Mr. Kuehn received a B.S. in Engineering Physics from Lehigh University in 1948 and continued graduate studies in optics, physics, and psychology. He is a member of Eta Kappa Nu and a Senior Member of the IEEE. He has published and presented papers extensively including short course lectures on Information Display Systems at UCLA and the American University, Washington, D.C.

Avakian and F. Walter Jenison

VOICE-RESPONSE and VISUAL-DISPLAY TECHNIQUES for ON-LINE INFORMATION-HANDLING SYSTEMS

ABSTRACT

Techniques and applications for a voice-response system currently in operation, and for visual-display devices currently in production, have been developed to maximize physiological throughput. Physiological throughput is a function of basic psychological as well as physiological factors which are only beginning to be acknowledged in theory and in the design of equipment utilizing man's perceptive, comprehensive, and motor abilities. Visual-display devices have been incorporated into data-entry and retrieval subsystems fully adaptable to available data-processing equipment.

Computer-assembled messages of prestored audio words, when used in certain on-line applications, form an efficient presentation of information for substituting for or supplementing of visual displays. The large-scale, audio-response system serving the American Stock Exchange since May, 1964, demonstrates a successful system solution to the requirements for an on-line, non-lockout, fast-response system with an audio response via standard telephone circuitry.

The applications for such on-line equipment when integrated into data-handling systems include various areas such as transportation, finance, hotels, institutions and industry.

Introduction

The programmed computer or data processor, integrated with a hierarchy of storage devices and a direct and responsive data-communications system, permits dynamic and immediate processing of information for a large and diversified group of users. This form of information processing involves both "on-line" and "real-time" techniques to optimize the man-machine interaction and to insure that the system reflects the second-to-second conditions of all parts; i.e., system conformity.

Display Requirements of On-Line Systems

The design objectives of on-line systems and particularly of the man-machine interface devices can be summed up by stating that the physiological throughput must be maximized. The physiological throughput is defined by two quantities: the rates of flow of "meaningful" information through the man-machine interfaces and the response time measured from the time of delivery of a "meaningful package" of information from the man to the machine to the time the man receives an amount of information sufficient to enable him to perform a task or to formulate a decision. While the system may present several such "packages" in a response to one inquiry, the response time is measured to the time of the complete delivery of the first meaningful "package" of information.

Research has explored the possibility of transferring information directly to man via the tactual and kinesthetic sense[1]. These senses are quite limited, and are not a natural channel to use. The information channels to man which are natural and broad are sight and hearing. The broadness of these channels is quite relative, because rates of information and to a particular person with a specific level of ability. However, an index of the information rate capability can be obtained by noting that normal speech is rated between 150 to 200 words-per-minute[2]. The design considerations of on-line displays must include the processes of comprehension and not merely the processes of perception. This requirement leads us to design information-presentation equipment not only in terms of individual character structure or sounds but also in terms of the entire presentation, emphasizing proper spacing and separation of areas of interest.

We speak of a man-machine interface in the singular, when we should consider man-machine interfaces in the plural. In the voice-response system, one interface transfers information from the motor actions of the fingers to a dial or touchtone handset; the other interface is the air which transfers information from the ear piece of the phone to the ear drum of the person. At the visual-display stations to be described, the two interfaces are, one, where the fingers meet the keys and two, at the line of sight where information is transferred from the image on the cathode-ray tube to the eyes.

Response Time

A major requirement for these interfaces is to have the response time in the range of two to six seconds. However, reducing the average waiting time one second can be quite costly in terms of hardware; the expense must be justified. Two factors have led us to design systems which have average response times of less than three seconds at display stations. Response times in this category are required where the performance of the operator is influenced by a waiting line such as at a bank teller's window

or at an airline reservations desk. These factors are the operator's physiological readiness to respond, the delaying of manual tasks, and the accompanying operator annoyance. More human-factors analysis by both industry and experimental psychology is needed in order to find suitable compromises between the reduction of response time and the increased cost of hardware.

The only experimental basis we have found to substantiate our experience over the last fifteen years in connection with response times in on-line systems has been the work of H. Woodrow[3] on reaction time. Woodrow gave a signal to his subject which he called a "ready" signal, and this signal was followed by the stimuli to which the subject was to react[4]. The time between delivery of the "ready" signal and the stimuli is the "foreperiod". Figure 1 plots reaction time and the foreperiod. The foreperiod was varied without the subject knowing its duration. The values of the reaction times are not of great concern here. What is of interest is the minimum reaction time and the slope of the curve with respect to the foretime. Woodrow's reaction time measurement is analogous to the speed and efficiency of the operator in handling the first comprehensible information displayed. The foretime is analogous to the response time at the display station. The operator presents his own "ready" signal by completing the inquiry; in other words, the operator gives himself a cue. The response of the system in the form of a display is the stimulus for the operator to react. The curve in Figure 1 indicates to the system designer that here might be a given minimum response time for an efficient system. In the literature of experimental psychology there is very little concerning experiments involving self-cues. It is hoped that some further work will be done in this area.

In Figure 2, the upper curve represents the reaction times of a subject who was given random foreperiods averaging eight seconds. The lower curve shows the reaction time of a subject who was told that the foreperiod would be incremented by one second every 25 successive trials. These curves indicate that the operator will improve his performance when the foretime is known. It is postulated that under self-cueing situations not only is the subject or operator of an on-line device aware of when the cue is to be given, but he also times the cue according to his own physiological processes. Woodrow's work indicates that a system is most efficient when the response time is between two and four seconds since this is the average foreperiod for which the minimum reaction times were obtained from all his subjects.

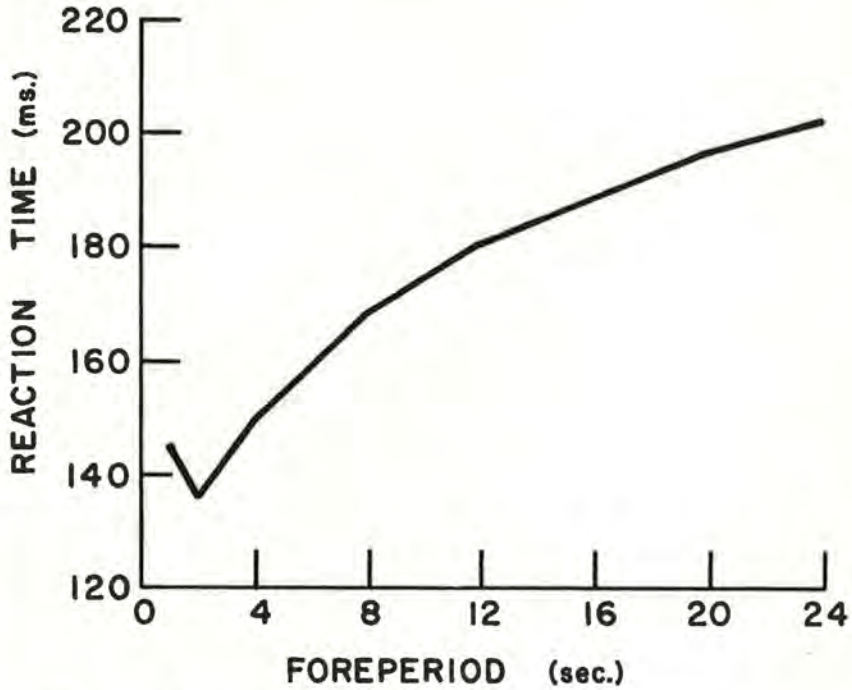

Fig. 1: Effects upon Reaction Time of the Length of the Foreperiod.

Fig. 2: Differential Effect of Regular and Irregular Orders upon Reaction Time.

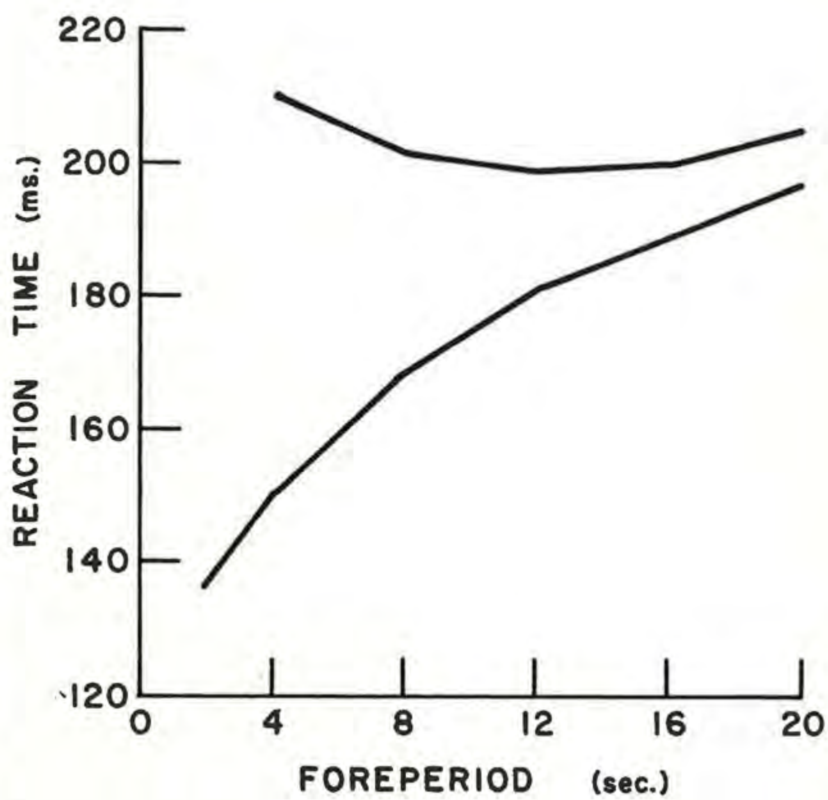

Fig. 3: Teleregister Model 212 Display Station

Our experience with on-line systems indicates that the annoyance factor introduced by delays in response times if plotted against time would appear similar to the lower curve of Figure 2. Several times it has been suggested, half in jest, that a buzzer or some noise be generated periodically during the waiting time to reduce the annoyance factor.

Other system considerations, beside the human factors, which must be considered in minimizing reaction time include queuing and traffic congestions at various points of large on-line systems[5]; these factors will not be considered in this paper.

Adequate Information Flow Across Man-Machine Interfaces

Having discussed response time, let us now consider the factors affecting the operator's efficiency of query inputting by motor activity and his perception and comprehension of the audio or visual presentation. A recent theoretical approach to the problem of "perceptual-motor integration" treats perception and motion as equivalent phenomena[6].

Several recent studies bear on the capability of man to transfer meaningful information by the motor activities of his fingers to keyboard actions, and thus to generate electrical codes. H. M. Bowen at Dunlap & Associates studied the relation of design to the ". . . flow of information and energy across the Stimulus-Response interface (i.e., the man-keyboard interface)"[7]. His findings indicate that for any class of keyboards, practice will result in an ultimate keying rate which is the same for various keyboards if basic human factor requirements are met[8]. However, the variation in performance on various keyboards relates to the proficiency per hour of training. To obtain this proficiency with minimum training, the grouping of keys according to functions is most important.

Thus, effectiveness is determined not by the strict information contents, or the mere permutation of keys in the communication theory sense of information content, but rather by the "meaningfulness" of the keyboard in terms of the information flow as part of the operator's task. It is interesting to note that the physiological throughput in terms of Bowen's findings for the rate of independent keying of Post Office addresses is approximately five bits-per-second[7] while Quastler[9] found that the rate of typing of randomly selected texts is 15 bits-per-second and piano playing is 20 bits-per-second. These findings seem to substantiate the proposition that the physiological through-put from man to machine is greater when the phrasing of information is such that it may be related to previously learned patterns or sequences; in the case of typing, this means the perception of words or phrases rather than letters. Similarly, on the machine side of the interface, the sequence of hand motions dictated by the layout of keys should relate to an ingrained sequence or grouping for greatest efficiency. This principle has influenced the layout of the touch-tone keyboard in a sequential manner starting from one at the upper left-hand corner[10].

Comparing the use of keys with such information input devices as dials and sliding knobs, one is impressed by the simple binary nature of a key. Dials and sliding knobs are not only analog devices; they also require grasping with the thumb and index finger. Grasping requires a more sophisticated motor activity than is required for a key depression.

Now let us consider the flow of information in the opposite direction; i.e., from machine to man. Here again we point out the importance of "perceptual-motor integration".

Recent research by Liberman[11] describes investigations which definitely link articulation or motor activity to the per-

Fig. 4: Cathode Ray Tube Display Device

ception of speech. In other words, as we hear, we subconsciously mimic and thus generate a reference feedback which in turn assists in the comprehension of what we hear.

We postulate that learned motor behavior in the form of articulation commands is cued by the perception of learned sound combinations. These sound combinations act as motor references which provide a feedback element for the comprehension process. While the research evidence is not as clear for visual pattern recognition as it is for speech perception, there is some evidence that images are comprehended by reference to formerly learned patterns, Platt, J. R.[12].

As shown in the case of the man-to-machine interface, the presentation of information by the machine to the man should also be such that the arrangement of the information will maximize the meaningfulness of the display in relation to the task to be performed.

Visual Displays

Speed of Presentation

The cathode-ray tube offers many advantages as a device for displaying on-line information. For many applications, the visual examination of several hundred words can be quite rapid, and it is now evident that the 10 to 40 character-per-second presentation rate of electromechanical printers is becoming a severe limitation. Average reading speed for Air Force officers has been measured to be 381 words-per-minute[13]. These cathode-ray tube devices can display 1200 or 2400 words per minute. Although this speed of presentation of information is faster than the above reading speed, information formatted in a meaningful layout can be comprehended by those familiar with the format and contents at rates comparable to these display rates. Provision is made to print the information required.

While there are applications which require graphic displays, most on-line information processing requires only textual matter and avoids the analog problems of input such as light pens.

Keyboard Arrangements

The display station shown in Figure 3 is an example of the Teleregister 200 Series equipment presently being marketed. To assure compatibility with available processors, the American Standard Code for Information Interchange is used.

The input device uses a block keyboard to aid in direct entry of fixed data. Below the cathode-ray tube are shown function keys grouped for ease of association. Some of these keys are used to move the cursor or entry marker allowing the operator to see the character position in which will appear the next character entered on the display at the depression of the next key.

The keys in the block to the right of the cathode-ray tube are used to enter the 26 alphabetic characters and up to six punctuation symbols. The numeric keys are located in a group at the lower right corner of the keyboard. We have purposely avoided the typewriter configuration of keys since this device and the one shown in Figure 6 assume a strictly formatted inquiry message.

In Figure 4 is shown a cathode-ray tube display station which permits a flexible message entry. It has a four-row communication keyboard in a typewriter configuration. The display capacity is up to 12 lines of 64 characters each. This type of station can be used with either the Teleregister 100 or 200 Series cathode-ray tube systems. The former uses a magnetic disc for refreshing up to 32 such display stations. The latter series uses delay lines to refresh up to 24 display stations. The refreshing rate is over 45 times-per-second.

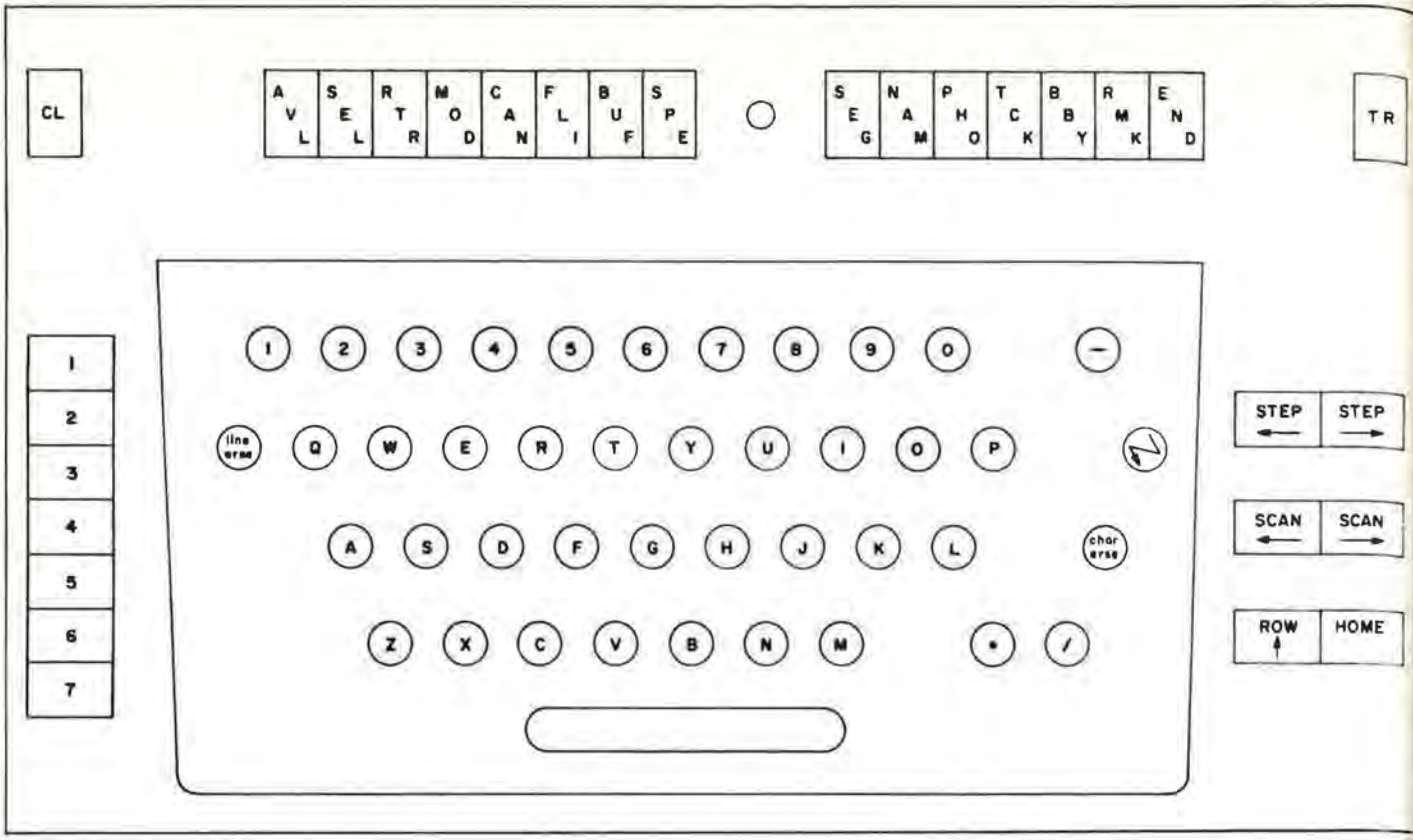

Fig. 5: Cathode Ray Tube Display Device—Keyboard Layout

The keyboard, a layout of which is shown in Figure 5, in conjunction with Table I illustrates the use of keys for effectively grouping parts of the message to be transmitted for an airlines reservation application.

The additional keys in the top row of the keyboard are the CL (clear) key and the TR (transmit) key. The latter key, when depressed, causes transmission of the fully assembled message to the central data processor. The processor will supply an acknowledge indicator, and a reply if required.

The depression of the carriage-return/line-feed key causes the cursor to travel to the left margin of the next line. The group of keys to the right of the alphanumeric keyboard assists the manual movement of the cursor. The top six keys to the left of the alphanumeric keyboard enable the operator to select one of six general information messages furnished by the processor. These messages cannot be altered by the operator. Depression of the seventh key permits the operator to display the contents of the buffer area assigned to him. This is the buffer over which his keyboard has control.

Figure 6 shows an on-line, man-machine interface device presently used in more than 400 stock brokerage offices. The use of this display clearly indicates that one-line cathode-ray tube input/output devices are acceptable to the business community. Alphabetic keys, in a block formation, are used to enter stock-identity characters. These characters appear on the first line of the display as the keys are depressed.

The dark-colored keys in Figure 6 are marked according to the type of stock information to be requested. This system deals with precisely formatted information, and the person requesting information is familiar with the format and knows the approximate quantities which he expects to be returned. Although this system contains a limited amount of information, this information is available at a high speed which permits the broker to respond immediately to his customer.

Time-Sharing of Equipment

The display subsystems which we have defined time-share equipment in three different areas. At the Remote Control Unit up to 32 cathode-ray tube stations can share the logic and power equipment to assemble, store, transmit, and display messages to and from the data-processor site. This action is accomplished with such speed that the operator is not aware of the time-sharing during manual entry. Secondly, several stations can share the data-communications circuits. Thirdly, at the processor site many circuit terminations can share the processing capabilities of a computer complex.

Voice As An Input/Output Display

As previously stated, the human ear provides a broad and natural communication channel. The ability to use voice communication as an input/output and machine-control media perhaps represents the ultimate in simplicity at the man-machine interface. Considerable work has been done toward this end. A brief discussion of some of this work may be helpful before describing the Teleregister voice-response system.

Voice Recognition

The ability, thus far, for electronic equipment to react to voice command is quite limited[1]. The problem of electronic voice recognition is complex in that speech sounds must be differentiated within narrow limits, or, the equipment must have the ability to place the speech sounds into context.

The experimental work done to date involves the ability to recognize a small number of finite commands, usually given by a specific person.

The restrictions placed upon the command utterance, thus far, seriously limit the general application of the technique. However, work has been done recently which indicates that a wide application

may be feasible[14]. As will be seen, more work has been done to date on voice as an output than as an input.

Speech Generation

The technique of electronic speech generation has been mastered in the basic sense [15], but has not been developed at present to the degree where it is practical to convert digitally stored alphanumeric information directly to speech. Speech generation is differentiated here from the technique of reconstructing speech from digital notations of analog speech patterns. This technique is commonly used in bandwidth compression systems. Franklin S. Cooper at Haskins Laboratories has defined speech generation as the process of "Speech Synthesis by Rules." This process involves "a conversion of input symbols into machine control signals, and then the utilization of these signals by an appropriate synthesizer to generate speech"[16].

Audio Output Displays

Extensive laboratory work has been done by Haskins Laboratories[17] on "speaking machines" which would use a stored vocabulary of pre-recorded words. The term "speaking machine" implies the capability of reading a text, and generating equivalent voice messages. A specific application for such a machine would be to read a newspaper or book for a blind person.

The pre-recorded vocabulary or "compiled speech"[17] approach raises severe intelligibility problems when applied to general text messages. Since the message context is not known, the vocabulary must be prepared in a manner which provides at least an approximation of the intonation and inflection inherent in normal speech. A flat intonation for long messages causes a monotony which detracts seriously from comprehensibility.

Let us briefly explore the problems involved in establishing a basic vocabulary, bearing in mind requirements of random assembly, intelligibility, and acceptance by a wide audience. Practical parameters limit the number of vocabulary words stored to a few thousand, and limit the programmatic capability available for message assembly. These parameters necessitate the storing of words which can fit a multiplicity of situations. An example of this problem would be the verb "close" and the adverb "close" as used in the phrases "close the door" or "close to the door." The words appear identical, but take on different meaning through inflection when spoken, or by association or context when read.

The stored vocabulary approach cannot completely cope with the problem of proper names or infrequently used terminology. This problem can be approached from two directions:

1. to add the required words to the vocabulary on an as-needed basis, or
2. to utilize the technique of spelled speech.

Extensive work has been done by Metfessel[18] at the University of Southern California on spelled-speech techniques. One advantage of spelled speech can be seen in that a relatively small vocabulary of alphabet sounds is required. However, a new set of problems arises from the fact that a mental translation must take place to perceive the sounds as words or phrases, and to put them into a meaningful context. This process approximates the learning of a new language. Experiments to date indicate that a rate of 80 to 90 words-per-minute can be achieved with spelled speech[18].

This brief description of speech techniques was not given with any pretense of covering the field, but merely to try to establish some understanding of the problems and progress surrounding the development of audio displays for input/output applications.

The Teleregister Corp., now The Bunker-Ramo Corp., has built and installed a voice-response system currently in use in New York City. The system has a pre-recorded vocabulary containing a combination of 62 letters, words and numbers. The maximum message length is 66 words. Many of the vocabulary problems related to the speaking machine previously described were encountered in designing the audio portion of the system.

However, there are some important differences in application which should be considered. The described system has a short message length, a relatively fixed message text and format, and an audience thoroughly familiar with the message context.

The system currently supplies the American Stock Exchange AM-QUOTE* quotation service to the New York brokerage community. Information is stored for a total of 2000 different stocks. This information can be accessed simultaneously, over a total of 1024 telephone lines at a rate of 1200 queries and responses per minute.

*Trademark, American Stock Exchange

Table I: Key Grouping for Airline Reservations Input

Field Key	Explanation of Transaction
AVL	Availability of Space
SEL	Sell Space
RTR	Retrieve Passenger Record
MOD	Modify Passenger Record
CAN	Cancel Space
FLI	Flifo — Flight Information
BUF	Display of information in the Agent Position Buffer at the central processor site
SPE	Special — reserved for supervisory sets

The seven Field Keys, located to the right of the Function Keys, are field identifiers used in connection with the procedures for entering passenger record information.

Function Key	Explanation
SEG	Segment
NAM	Name
PHO	Phone
TCK	Ticket Information
BBY	Booked By
RMK	Remarks
END	End of Record

Each field or function key depression causes an immediate display, usually of the first letter of the appropriate designation. The letter displayed is underlined for quick identification of field or function. It should be noted that the RTR key designation will appear as I on the display to differentiate the abbreviation from the RMK key designation appearing as R on the display.

Fig. 6: Telequote III Video Unit

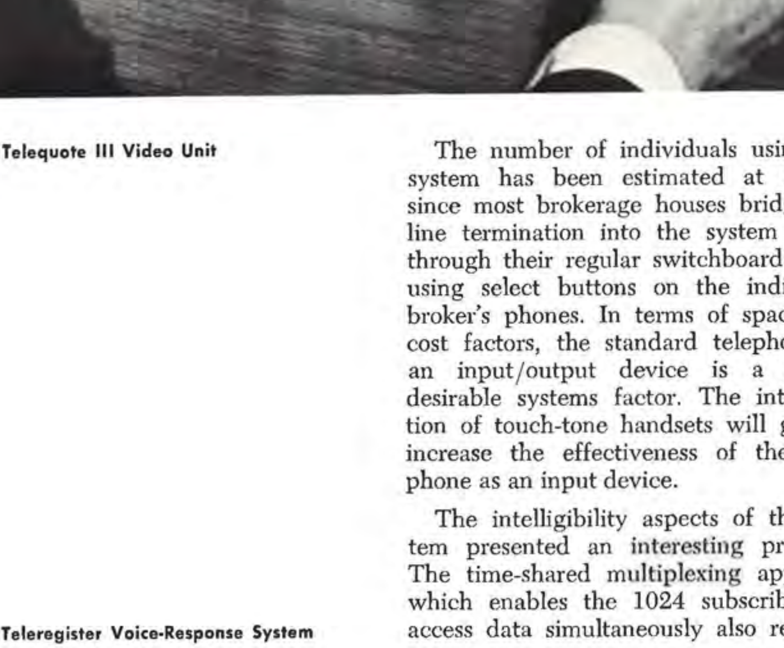

Fig. 7: Teleregister Voice-Response System

The number of individuals using the system has been estimated at 10,000 since most brokerage houses bridge the line termination into the system either through their regular switchboard or by using select buttons on the individual broker's phones. In terms of space and cost factors, the standard telephone as an input/output device is a highly desirable systems factor. The introduction of touch-tone handsets will greatly increase the effectiveness of the telephone as an input device.

The intelligibility aspects of the system presented an interesting problem. The time-shared multiplexing approach which enables the 1024 subscribers to access data simultaneously also requires that a fixed-word length be used. This necessitates the presentation of words such as A, B, etc. in the same word time as "thirteen", "fifteen", and "quarters", etc. This restriction alone will remove the response from the area of normal speech. In addition, a primary requirement of the system was to give the response as rapidly as intelligibility would allow. Considerable experimentation was involved in arriving at a word time of 350 milliseconds and a presentation rate of 150 words-per-minute. After nearly four months of full-time operation, it now appears that a slightly faster presentation rate might be desired.

The random-assembly technique requires a constant intonation of all the letters and numbers. This is acceptable with the short message length. Pitch was a particular problem with the letters and numbers, in that nearly unmeasurable differences in pitch can be intolerable to the human ear. Slight inflection was permitted on certain identifying words which apear in fixed locations in the message as an aid to comprehension.

Words such as "sixteenth" were too long to fit into the allowable word time. These words were segmented by breaking up the word into word segments which can be re-assembled as the messages are constructed.

The experience to date with the system indicates that, in spite of the mechanical nature of the audio reply, system users are getting a higher level of intelligibility than from the manual call-out system it replaced.

Voice-Response System Description

The voice-response system shown in

Figure 7 provides spoken information in response to the dialing of a four-digit query.

The system is designed on a no-lock-out basis; i.e., all 1024 subscribers will never receive a busy signal. In order to achieve economy in providing this grade of service, input/output multiplexers are employed to time-share the common system logic[19]. A line is activated when a subscriber lifts the telephone handset from its cradle. Thereafter, the line is monitored continuously by the input-query logic to detect the presence of line pulses. The line pulses are transmitted at a rate of 10 pulses-per-second, the transmission being initiated by the dialing motions of the subscriber. The query-input logic assembles the query, digit by digit in a four-digit query area for each subscriber. If the subscriber makes an error during dialing, the erroneous entry is cancelled automatically when the telephone receiver is replaced.

When a query is assembled, the bid logic generates a bid for the data-selection logic. The assembled query is directly related to the address of the requested data. The conversion is effected by the data-selection logic. The requested data is extracted from the data source, held temporarily in the reply buffer, and transferred to a location which is assigned to the particular subscriber's line, the subscriber's reply area. The extracted data consists of a sequence of switching characters, one character for each word required.

The subscriber's reply area consists of 66 tracks on the query reply drum. Each track can accommodate a binary-coded character for each subscriber. The audio conversion proceeds by reading out all 1024 characters from one track and using them to select and set a series of switches in the audio multiplexer. The switches connect each subscriber's line to any one of the 62 audio words. All the switches are set simultaneously, and the selected words are transmitted on the lines for one word time. At the end of this time, the reading head associated with the subscriber's reply area switches to the next track and a new set of words is selected.

A reply is transferred to a particular reply area in a few milliseconds. The transfer is accomplished under control of the reply-sequence logic so that the first word of a new reply is stored one track in front of the active reading head. Therefore, after acceptance of a subscriber's query, the subscriber will wait no longer than one word time before hearing the beginning of the information which he has requested, even if all subscribers request the same information simultaneously. While one subscriber is still receiving the end of the message, another receives the beginning; but, all replies always start from the beginning of the message.

This type of voice-response system can be applied to a number of situations where a relatively small vocabulary is sufficient for messages to be disseminated to a relatively large number of system users. Applications of this nature might be to provide flight information at airline terminals, and also, through normal PBX dialing, bank balances, account balances, inventory balances, etc.

Conclusion

The feasibility of time-sharing a large and costly data-processing complex has been demonstrated by Teleregister airline, bank, and brokerage systems over the last 15 years. In each system, hundreds of operators use one central computer directly and simultaneously. Indications are that such systems will find even wider use as evidenced by the recent work of Bolt, Beranek and Newman in the area of on-line data-processing for hospitals,[20] the work of Calvin Mooers at the Rockford Research Institute,[21] and the work for the MAC project at the Massachusetts Institute of Technology for time-sharing data-processing equipment on a university campus.

To assure the efficiency of such systems, a compromise between hardware and the factors leading to maximum physiological throughput must be achieved. We have introduced the term physiological throughput to focus attention on the total process of information interchange at the man-machine interfaces. We have made some postulations, calling upon experience within our company and certain basic research. A greater emphasis must be placed upon interrelating the work of the experimental psychologist with interface design. Only through this type of activity can we hope to build future on-line systems which are fully reactive to the needs of man.

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FIGURE 1. Operations Area, Space Flight Operations Facility, typifies integrated communications/display installations at Jet Propulsion Laboratory.

THE JPL SPACE FLIGHT OPERATIONS FACILITY DISPLAY and CONTROL SYSTEM

– PRESENT EXPERIENCE and FUTURE REQUIREMENTS

by Albert S. Goldstein

ABSTRACT

The Jet Propulsion Laboratory (JPL) Space Flight Operations Facility (SFOF) was designed and built to provide a centralized installation for the conduct and control of unmanned space flight operations. The SFOF incorporates integrated communications, data processing, display and control subsystems.

The initial configuration of the SFOF Display Subsystem consists of closed circuit television, manually stimulated electromechanical displays, and large screen projection displays. A study is being conducted to automate the SFOF Display Subsystem. Future operational requirements and display techniques suitable for automation are being investigated in the study.

This paper summarizes the design philosophy leading to the current display subsystem and discusses experience gained from the use of the display subsystem under actual operating conditions. Future SFOF display requirements are also presented along with a summary of the results of a survey of current display techniques and devices. The survey contains information on panel-type displays, projection devices, and other display techniques with emphasis on their applications and suitability to SFOF display requirements.

I. Introduction

A. The Space Flight Operations Facility

The Jet Propulsion Laboratory (JPL) Space Flight Operations Facility (SFOF) is a multistoried building containing the accommodations and facilities required to provide, as a service, a relatively mission-independent capability for the conduct of space flight activities. Mission-independent refers to personnel and equipment whose functions in space flight operations are performed for all flight projects conducted from the SFOF. Examples of mission-independent equipment are the data processing complex (not including mission peculiar programs), SFOF display equipment, and communications equipment. Examples of mission-independent personnel are data processing and communications operators and facility management personnel. This paper summarizes the design philosophy leading to the current SFOF Display Subsystem and discusses experience gained from the use of the Display Subsystem under actual operating conditions. Future SFOF display requirements discussed are not necessarily specific or selected approaches that have been finalized by JPL.

B. JPL Design Philosophy for Phase I of the SFOF

Experience at JPL has indicated that space flight activities can be most effectively executed when the informatio

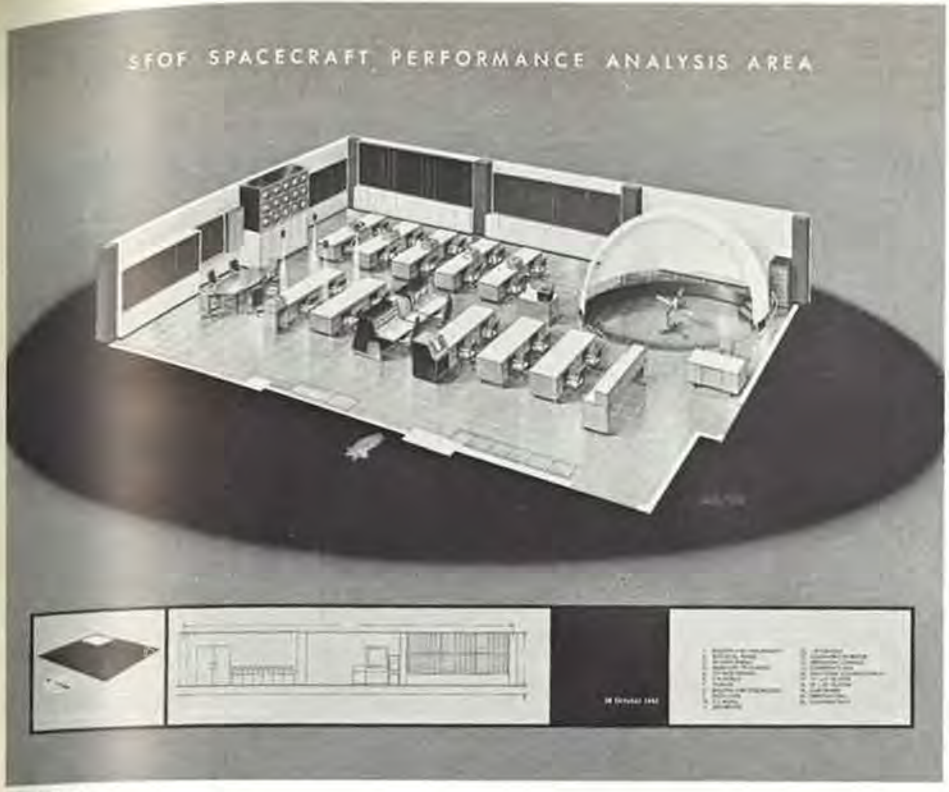

FIGURE 2.

FIGURE 3.

processing, display, analysis, and communications functions associated with flight operations are centralized. Centralization of mission-independent facilities was a primary design principle.

An important design criterion for the SFOF is the capability to support, simultaneously, more than one multiple mission in real time. Real time is defined as being able to react to a situation within five minutes upon receipt of data from a tracking station to the SFOF.

In the design it was recognized that personnel are an integral part of both mission-dependent and mission-independent operations in the SFOF. The real time requirements are less stringent than those in military systems and integrating the human being properly into the operations is more advantageous than attempting to completely automate the decision-making operations.

C. The Initial SFOF Configuration

The SFOF in its present configuration was officially dedicated on May 14, 1964. This initial configuration has been designed and implemented to conduct the real time portions of one mission concurrently with the nonreal time portions of a second mission. This facility design was accomplished with the aim that the SFOF in a final phase will be capable of simultaneously controlling two or more missions in real time, and two or more missions in nonreal time.

The first mission conducted from the SFOF was the highly successful Ranger VII which was successfully launched and impacted on the Moon, and transmitted photographs of the lunar surface. Testing and preparations were recently conducted in support of the attempt to launch the two Mariner Spacecraft during the open Mars launch window. Other missions scheduled to be conducted from the SFOF are two Rangers in early 1965, Surveyor, Pioneer, and Lunar Orbiter.

Figures 1 through 5 indicate some of the present facilities that are now in actual operation.

II. The SFOF Display System

A. Introduction

The original display design concept in the SFOF development included the use of large wall-mounted group displays as well as individual console-mounted television displays. The large group wall displays presently consist of projection systems, remote manually controlled electromechanical alphanumeric displays, racks of wall-mounted television monitors, ceiling-mounted television monitors and preformatted chalk boards. Also displaying data and information are automatic computer printers, automatic plotters, and console-mounted status indicators closely associated with the Data Processing Subsystem. Teletype printers are being used as interim data printers.

Display requirements were classified into two categories: individual requirements and group requirements. Displayed information is classified into summary, semi-detailed, and detailed technical and operational information.

From our experiences, individual display requirements are relatively easier to define but are more technically difficult to implement and have high costs. Group display requirements were extremely difficult to define and their implementation represented severe compromises. Thus, it was decided in the initial design phase of the SFOF to implement a relatively inexpensive but flexible display system. The design of the interim SFOF was predicated upon meeting an early operational date. In addition, it was felt that experience with the facility would aid in better definition of requirements and allow for more efficient and economic design and implementation of future equipment. The entire SFOF is a learning device as well as an operational facility.

The initial SFOF Display System is a compromise between group and individual displays. A 525-line closed circuit prepatched television system was designed for use as both individual and group displays. Television has served excellently as an individual display but has some shortcomings as implemented for group display. It was felt at the time of the original SFOF design that many group display techniques available were too expensive and unreliable. Therefore, most group displays in the SFOF consist of electromechanical digital data units remotely controlled through manual control boxes, and banks of television monitors. There are over 3,500 digital data units installed and used throughout the SFOF. There are 100 closed circuit television cameras and more than 200 television monitor displays. The console-mounted television displays can provide up to 66 patched connections. The wall-mounted and ceiling-mounted television monitors are patched to a preselected camera. Hard copy image, administrative information, time, status and summary technical information, and teletype information are all distributed throughout the SFOF via closed circuit television.

B. Operations Area Displays

The dynamic focal point in the SFOF is the Operations Area (Figure 1). This area contains a Facility Control Room that provides space for an SFOF Operations Manager and a Deep Space Instrumentation Facility (DSIF) Operations Manager. These two positions coordinate and control the mission-independent facilities required to support flight projects. On either side of this room are the Mission Control Rooms from which a particular mission is directed and controlled. Located in front of these Control Rooms is an area in which various technical analysis area representatives who function as advisors to the Space Flight Operations Director (SFOD) may be located.

FIGURE 4.

Thus, within seconds, representatives of all the operational and analysis functions can be gathered in a small area to discuss and intepret events and occurrences, and then make recommendations for actions to the Flight Project Manager and the SFOD. These personnel have extensive communications facilities to all parts of the SFOF.

An adjacent area is the Planetary Operations Room from which a flight project can operate during the long, low activity (cruise) periods which are characteristic of planetary missions. Above the Operations Area is a gallery from which interested parties can observe the progress of a mission without directly physically interfering with in-line mission personnel.

The central point of attraction and the most interesting display in the SFOF is the Mission Status Board (MSB) (Figure 6). This large display board measures 60 feet long by 10 feet high and is the main group display. It contains both mission-dependent and mission-independent data. The central segment of the MSB is devoted to mission-independent data such as the status of communications and data processing systems and a GMT Time Display.

On segmented sides of the MSB are identical mission-dependent displays. These areas display summary status information about specific experiments on a spacecraft, performance of spacecraft subsystems, and flight path information. There are two projection screens on each segment for displaying scheduled mission events and for displaying special events. The alphanumeric digital data displays are remotely controlled and the projection displays are operated from a rear projection area. The entire MSB is remoted by closed circuit television to various areas in the SFOF.

Current plans call for design and enlargement of the MSB so that it can display information for four missions simultaneously. Experience gained from operating the current MSB indicates th

FIGURE 5. SFOF Communications Control Area.

FIGURE 6. SFOF Mission Status Board.

there is too much detailed alphanumeric data displayed for a mission. Therefore, it appears that more projection type displays will be implemented and alphanumerics will be limited, for mission displays, to spacecraft subsystem GO, NO-GO information. The current projection devices installed are two Eidophor light valve projectors used in conjunction with the Closed Circuit Television System, and simple slide projectors. Techniques of automated projection systems and computer controlled alphanumerics and indicators are being studied and considered for future implementation.

C. Technical Area Displays

Adjacent to the Operations Area are several technical analysis areas in which the detailed analysis and interpretation of data are performed in both real and nonreal time (see Figures 2 and 3). There are two types of group displays implemented in these areas. One type is the detailed alphanumeric display consisting of remotely controlled digital data units (see Figure 6) and preformatted and unformatted blackboards. The other type of group display is a bank of rack-mounted twenty-four inch television monitors.

Experience in these technical areas indicates that the alphanumeric digital data unit displays have been received favorably by operations personnel. However, the major complaint about them has been the time it takes to update them with a thumb-wheel control. An interim keyboard control device is being implemented in one display and it is expected that the most critical displays will eventually be computer driven. It has also been requested that some of the blackboards be replaced with the digital data unit boards.

The large banks of television displays have caused various negative reactions. They are difficult to read and seem distracting to many individuals. The general trend is to keep television as a display but to break up the large banks of monitors (in some cases 30 monitors) into subsets located conveniently near different groups who will have some selection capabilities. The ideal or ultimate system is to have television monitors for each individual with a large channel selection capability and some of the data presentation controlled from a computer.

The feasibility of having a computer driven closed circuit television system is being studied. As missions become more complex and contain stringent real time requirements, computer controlled displays may become necessary. In the initial design phase of the SFOF it was felt that known display requirements did not justify an automated display system. Any computer driven closed circuit television display system would probably have to be compatible with the 525-line system and make use of some of the equipment presently in use.

III. Summary of Future Display Requirements in The SFOF

Experience with the current SFOF Display System indicates the necessity for individual displays. Group displays are limited to low density information and at the same time they are required to serve the needs of various personnel with different interests. There is a place for group displays for the purpose

of disseminating summary and status information and for off-line and public display. It seems at present that most large group display techniques suitable for control by a computer fall into the category of projection type displays.

The need for individual displays with greater density of information and selectability has been demonstrated in the SFOF. Closed circuit television seems to be the only currently proven and available technique for fulfilling this individual, real time display requirement.

Display techniques for large amounts of alphanumerics that are being studied for possible future use in the SFOF include electroluminescence, fiber optics, film projection systems, and computer driven cathode ray tube presentations.

Group display techniques being considered and studied include devices such as film systems, slide projection systems, and light valve projectors. There is currently a three-dimensional display in the SFOF which is an analog computer driven scaled-down model of a spacecraft on a three-axis gimbel system. (See Figure 7.) Future requirements of more complex space missions may force us into evolving some sort of true three-dimensional display, but preliminary studies indicate a lack of development by industry in this direction.

FIGURE 7. SFOF Functional Spacecraft Model.

The Data Processing System in the SFOF provides both on-line data acquisition, processing, display, and command/control functions, and off-line bulk processing, and is built around a multi-computer subsystem. Two IBM 7040 computers each with an IBM 7288 data communications channel are used as the input/output processors. Two IBM 7094 computers are used as the main processors, and two IBM 1301-II disc files accessible from all the computers are used for storage of both data and programs. This computer system is expected to be improved and updated within the next two years.

Computer driven displays will probably use the 7040 and 1301 disc (or updated versions) to obtain the data. Raw data input in real time that requires processing for display will probably involve additional processors and buffers as part of the Display System. Therefore, the design of any computer driven display system in the SFOF will have to be compatible with the presently implemented Data Processing System.

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DISPLAY REQUIREMENTS of the INTEGRATED MANAGEMENT INFORMATION SYSTEMS - 1968-1970

by Peter James and Donald L. Dittberner

ABSTRACT

By 1970, with advances in control and reproducibility of displayed materials, the advent of reusable films, and overall cost reductions due to increased production levels, nearly every large integrated management information system will have many displays associated with it. Capabilities such as high resolution character formation adequate to obtain lithographic quality reports open the door to many new commercial uses for displays.

Principal categories of use include simulation, information storage and retrieval, browsing, message composition, high quality recording, and industrial education. Mixing of stored graphic (microfilm and video) information with computer generated data will become the rule rather than the exception. This use will be slower in obtaining general acceptance than other technical advances such as memory technology and improved data collection devices. Nonetheless, from the integrated management information system viewpoint, displays offer one of the few tools which will be helpful directly to the highest level of management, and a tool that must be exploited in order to obtain the full benefits of better accounting and control systems.

Fifty-eight display applications are identified by specialization or industry and categorized into seven classes of display capability. Price performance forecasts are given for each of the seven classes of capabilities for the years 1963-1965 and 1968-1970.

A. Forecast of Display Requirements of the Integrated Management Information System (1968-1970)

Visual displays, excluding hard copy output, have not yet become an accepted component even for advanced commercial information processing systems. However, it is anticipated that by 1970, with the technological advances in the ability to better control the quality and reproducibility of displayed materials, the introduction of reusable films for the temporary storage of displays for projection purposes and the over-all cost reduction which will result from the increased production level of these devices, nearly every large integrated management information system will have many displays associated with it. This forecast is more easily understood if we describe the anticipated functional capabilities which displays will make available during the 1968-1970 time period. These capabilities are:

1. Ability to browse through extensive detailed material without the inconvenience of page manipulation, carrying of heavy reports from location to location, and the delay involved in obtaining additional detail when desired.
2. Mixing of stored graphic or pictorial information with computer generated alphanumeric data.
3. Ease of manual alteration of displayed data.
4. Rapid access to an integrated data base without the delay inherent in hard copy mailing or reproduction.
5. Ability to enlarge, rotate, or reduce the size of displayed items under manual control.
6. Ability to enter information into computer data base and to verify the accuracy of the entry.
7. Ability to use the computational facilities of the computer to develop the implications of graphically presented design concepts.
8. Ability to use the computer to improve upon the limited mechanical drawing capabilities of the human user to develop detailed mechanical or network diagrams.
9. Ability to enter manually generated line drawing information super-imposed upon displayed data.
10. High resolution character formation adequate to obtain lithographic quality reports for subsequent reproduction both to senior management and to the public.
11. Ability to create inexpensive hard copy output upon demand of the user.

This indicates the general range of capabilities which will be made available during the coming decade. Many of these capabilities have already been proven out in special-purpose, few-of-a-kind systems. Typical options available with cathode ray tubes are given in Exhibit 1. Much of this functional capability will reside not in the display hardware but rather in the computer program. It is felt that much of the lack of effective utilization of even today's display technology has been the result of limited cooperative efforts to obtain adequate software support for the display function. The recent development of display user groups and the emphasis on display systems development and evaluation by the military, for both tactical and strategic command and control systems, will

Exhibit 1

TYPICAL OPTIONS AVAILABLE WITH CATHODE RAY TUBES (1968-1970)

Option Description	Advantages
1. Quality — Direct view — under 1,000 TV lines/inch; Display recording — over 1,000 TV lines/inch. Trade-off between electronics and optics.	Direct view trades quality for greater character selection; display recording trades selection for resolution.
2. Mixing video with fixed graphics — integrates or superimposes CRT images with film images.	Integrated, real-time displays.
3. Color (3-5) — practical uses up to six colors.	Increased information content readability and comprehension.
4. Hard Copy of Film Recording.	Information storage, make-up dissemination, delayed reading.
5. Light Pen — hand held.	Permits 'sketching' or line drawing, editing message composition. Hence facilitates computer-aided design.
6. Keyboard — Normally a typewriter keyboard; can be programmed keyboard.	Adds general purpose use of keyboard where computer defines functions of keys.
7. Variable Character Sizes — 7 to 9 TV lines required to form reasonable resolution of character.	Permits reducing or enlarging character geometry.
8. Simultaneous alphanumeric and video display — two gun tube co-displays (computer-generated data and video image).	Permits co-display of data where lacking system time.
9. Time sharing — one tube displays, in series, video or alphanumeric images; can be superimposed.	Greater writing flexibility.
10. Fiber Optics Tube — 'Pipes' image to outside surface of CRT.	Offers undistorted images for photographic reproduction purposes.

each contribute substantially toward the alleviation of this deficiency.

Importantly, the level of systems maturity in display approaches is rising. One facet of this maturity is the recognition that not all displayed material must come from a computer. The use of displays for combined or joint usage of data from the following sources will be observed during the next five years:

1. Information storage and retrieval systems.
2. Management information systems.
3. Data communication systems.
4. Industry oriented regional information systems.

B. Anticipated Functional Display Uses

Displays will become one of the principal tools emplyed by decision makers at many levels of responsibility within an organization — by operational management, design engineers, information specialists and operating personnel. The principal categories of use will be:

1. To observe the real-time performance of certain operational processes including simulated designs or models used to evaluate the probable effectiveness or result of a design or strategy decision.
2. To display retrieved information from massive graphic and alphanumeric data bases in time critical situations.
3. To facilitate leisurely browsing through microfilm or video records without the necessity or cost involved in hard copy reproduction.
4. To compose messages, make corrections or enter instructions via the input capability of the control console.
5. To facilitate the high quality recording of desired information, be it for future individual reference, or for subsequent high volume reproduction operations.
6. To serve industrial education purposes, as well as indoctrination and orientation on policy and procedural matters, in order to obtain rapid response of the organization to a new management direction.

One of the major lessons which has been learned from the more than $20 billion spent on the development of military command and control systems has been that data summarization for management decision is not sufficient. Rather, the ability to communicate the action implications of those decisions is equally important. This *communication* process will be radically improved with these new display technologies as well as by improved data communication network facilities.

The seven classes of display capability presented in Exhibit 2 and cross referenced to primary functions, applications, and specialization or industry in Exhibit 3 indicate the range of application of display technology to serve the many functions within a technical commercial organization. There is little doubt, however, that this use will be slower in obtaining general acceptance than advances in other areas, such as memory technology, improved data collection devices, etc. Nonetheless, from an overall management improvement viewpoint, displays offer one of the few tools which will be helpful directly to the very highest level of management within the organization, and a tool which must be exploited in order to obtain the full benefits of better accounting and control systems.

C. The Role of the Cathode Ray Tube

Basic cathode ray tube technology utilizing complex electromagnetic deflection techniques will remain the work horse of display generation equipment. This is true of not only console displays, but also for the large-screen displays.

For the latter, a CRT has insufficient light output to be used directly for a large area display. Hence, the cathode ray tube must be employed only as a control mechanism by which a high intensity light source is used to create a large display capable of being viewed under normal room lighting conditions. Two essential techniques by which the CRT can be employed are for film or 'light value' large screen displays recording as follows:

1. *Film Recording*

To selectively expose a photograph film, frost and thermoplastic material, or photochromatic film which is subsequently developed (fixed) and used in normal projection slide fashion.

2. *Light Valve Recording*

The use of electrostatic properties of the electrons deposited by the CRT gun to obtain a dynamic temporary storage of a visual image. These electrostatic properties of electrons permit a thin film of liquid to be easily distorted or wrinkled. The nature of this storage media provides either for the

Exhibit 2

SEVEN CLASSES OF DISPLAY CAPABILITY

Class I	Low quality, direct view, console
Class II	High quality, direct view, console
Class III	Low quality, direct view, large screen
Class IV	High quality, direct view, large screen
Class V	Electroluminescent and alphanumeric panels (1,000 characters)
Class VI	Low quality cathode ray tube recorder (Under 1,000 TV lines/inch)
Class VII	High quality cathode ray tube recorder (Over 1,000 TV lines/inch)

direct reflection (flat area) or diffraction (wrinkles) of the light from a high intensity light source falling upon it. Hence, it provides a 'light valve' by which the image impressed upon it by the electron beam is transformed into an optically active surface. This intensified image can then be projected onto the display surface with a suitable lens system.

D. Character or Symbol Generation Techniques

More than a dozen character or symbol generation techniques have been successfully employed to convert an alphanumeric character code into an equivalent optical character. Certain of these approaches have proven to be more applicable to low-speed high-resolution requirements and others to inexpensive direct viewing displays only.

These techniques also vary substantially in terms of the size of the character set which can be represented. Many of the more conventional approaches have a very limited alphabet of 64 or 256 characters. The unlimited character selection techniques require a substantially longer time for character generation and are limited in their speed of updating an entire display.

1. *Closed Stroke Symbol Writing*

   This appears to be one of the most promising methods for generating characters with a high aesthetic quality. A large number of different characters can be generated from these individual segments and different fonts can be stored in manually interchangeable units.

2. *Dot Pattern Method*

   Forms characters from a series of overlapping dots. This technique is compatible with normal closed circuit TV representations and will persist for many direct viewing displays.

3. *Magnetic Memory Scanning Methods*

   Stores the controls for individual character formation is small magnetic memory planes. Cost reduction achieved by micro-electronic circuits will benefit this approach.

4. *Image Converter Tube*

   Employs the scanning of a preformed character stored on the large segment of one tube to create a much reduced character with high resolution on the face of another CRT.

5. *Videograph and Printapix Approaches*

   Converts video information into visual presentation on a dielectrically coated paper. It utilizes a cathode ray tube whose face plate is equipped with an array of finely spaced wires passing through the glass to the outside of the tube. Thus an electrostatic image can be deposited on the surface

Exhibit 3
DISPLAY APPLICATIONS 1968-1970

Primary Function	Applications	Specialization/Industry
Class I		
Operational Management Control	Information Storage and Retrieval Inventory Control Inquiry Stations Credit Investigations Process Control	Insurance Hospitals Banks Legal Oil Manufacturing
Engineering	Rough Design and Layout Simulation Flow Charts	Aerospace Mathematics Data Processing
Computer Programming	Program Test and Debugging Program Development	Data Processing Programming Numeric Control Programs
Class II		
Editorial Review	Editorial and Composing Technical Manual Edit Newspaper or Mag. Edit	Printing and Publishing Theatre
Data Preparation	Data Entry Data Origination Form Preparation Program Development	Management Data Processing Manufacturing Communications
Designing and Layout	Art and Illustrations Graphic Displays Engineering Drawings Technical Manuals	Aerospace Manufacturing Printing and Publishing
Class III		
Technical and Education	Reliability Training New Product Training Executive Training Corp. Policy Dissemination	Manufacturing Sales Management
Monitoring and Simulation	Receive only Monitoring Business Games Business Planning	Management Mathematics Statistics Medicine
Co-ordinated Group Decisions	Management Control Real-Time Control Systems Information Storage and Retrieval	Management Manufacturing Printing and Publishing
Class IV		
Group Conferences and Promotions	Board of Director Meetings Business Planning Promotions Closed Circuit Television	University Management Marketing Motion Picture
Action Displays	Real-time control of complex-operations Process Control Graphic/alphanumeric data bases Movies Traffic Control	Communications Transportation Petroleum Aerospace Entertainment Education
Class V		
Status Boards/ Alphanumeric Displays	Stock Quotations Production Control Inventory Control Spectator Display Panels Real-Time Operational Data Medical Instrumentation Readouts Indoor/outdoor Advertising	Finance Manufacturing Logistics Entertainment Management Medical Advertising
Class VI		
Film Viewing with hard Copy Reproduction	IS & R Information Dissemination Facsimile Label Printing Computer Output Storage	Credit Bureaus Library Engineering Legal Transportation Data Processing
Class VII		
Printing and Publishing	Technical Reports Management Reports Text Preparation High Speed Facsimile Phototype Setting High Speed Printing High Resolution Film Recording	Newspapers Printing and Publishing Information Centers Motion Picture Advertising

of a dielectrically coated paper placed against these wires, and a visible image formed by dusting with an electrostatically active toner subsequently fixed by heat processing. The Printapix tube currently has twice as many wires per linear inch in the face of the tube as the Videograph, thus permitting higher resolution and faster printing.

6. *Charactron Shaped Beam Tube*

Deflects an electron beam through a metal stencil contained within the neck of the tube. The metal matrix intercepts all of the beam current except that forming the desired character. This shaped electron beam is subsequently deflected to the desired position on the phosphor screen to obtain an optically visible character.

7. *Standard Television or Video Techniques as Adapted to Closed Circuit Direct Viewing Applications*

Currently employs 525 TV lines over the face of the tube with interlaced raster scanning to obtain an acceptable image. 1,000 line closed circuit systems will soon be commercially available at an attractive price, with 1,500 line scans over the face of the tube available by 1968.

E. Large Board Displays for Image Projection

There are essentially two interesting approaches to the creation of an intensified and enlarged image for large-screen display purposes. These are:

Film projection systems:

- Normal photographic film
- Reusable film (photochromic or frosted thermoplastic)

Light valve projection systems:

1. *Film Projection Systems*

a. *Normal Photographic Film*

Film projection systems will be the most frequently employed large-screen display system where updating in seconds rather than microseconds is adequate. The major differential in prices of film systems surprisingly will not lie in the relative speed of updating. In fact, the low cost systems will enjoy the same update times of the more sophisticated systems. The sophistication, hence high prices, stems from the amount of (user) control and option features of the system, as well as higher image quality.

The system performance characteristic that distinguishes this means of display from standard, low cost, commercial, film projectors is the rapid processing of film that is employed. The processing may begin with computer-generated information which is fed to the face of a CRT. The CRT image or other suitable image is photographed by a specifically designed film (color or monochromatic). The film is then processed. Color processing takes from ten to twelve seconds while monochromatic takes only three seconds. By 1968-1970, these times should be reduced to four and one seconds respectively. Until reusable film becomes available (1968-1969), these systems may be unattractive for high frequency of update application since the amount of film consumed annually can reach 10 to 50 per cent of the system price. Mechanical transport malfunctions, optical color distortion, and high operating costs (personnel, power, and film) are characteristic. For these reasons the life expectancy of film system technology is under challenge, but it is forecast that no substitute technique can displace film transport projection prior to 1970, except where faster than one second update time is essential.

Film systems are the most mature in terms of quality (resolution), reliability (MTBF and availability) and acceptability. A minimum amount of training (operational and maintenance) is required. Mass production of any specific hardware configuration in large quantities offers the promise of major price reductions. Further, the Federal Government is funding several rapid development dry process and reusable film developments, any one of which will result in substantial operational savings within 5 to 8 years.

b. *Reusable Film*

1) *Photochromic Film Display Storage*

Slides coated with photochromic material may be used for dynamic writing. The molecules in the photochromic coating are switched from transparent to an opaque colored state by the application of a light beam. The selection of dyes controls the fading of plotted information (persistence of the opaque state ranges from a fraction of a second to hours). The same light source may project fixed background information, computer generated characters, or analog plots. By 1968, a photochromic display will accept CRT output, employing a flat face fiber optic tube and a very thin ultra phosphor.

The principal advantage of photochromic display is the reusability of the slide. Further, update times of better than one second will be feasible by 1968.

Another major potential for photochromic systems is the development of electronically deflected laser beam photochromic displays. Such systems should be available by 1972.

2) *Thermoplastic Film Display Storage*

The thermoplastic or frosted thermoplastic film approaches to a reusable medium for the temporary storage of a display image from the face of a CRT for light amplification purposes will be available in the 1968-1970 time period. They will offer processing (updating) times measured in tenths of seconds, but their main advantage will be the ease with which both CRT-generated and stored pictorial data may be combined for display purposes.

2. *Light Valve Projection Systems Including Eidophor*

This principle of operation combines CRT tube principles with an oil film which is used as a control layer to selectively reflect or scatter light from a separate high intensity light source. An electron beam is directed within an evacuated chamber at a glass disk, one side of which includes a transparent (charged) conductive layer, and the other side of which supports a thin oil film (control layer). The electrostatic force between the electrons deposited on the oil, and the charged conductive layer deforms or wrinkles the oil film. The equivalent phenomenon of an optical lens is created when the electron beam causes a deformation of the oil surface layer. The high intensity light source focused on the control surface is selectively reflected through a projection lens to the display surface.

Present resolution of 525 TV lines will be extended to 1,000 TV lines for general commercial availability by 1967-1968. Initial implementation will employ the Eidophor technique for theatre television, stockholders meeting, etc.

Other light valve approaches include ultrasonic light modulation techniques. These techniques promise a resolution of 2,500 TV lines by 1970.

Technical problems in light valve developments are very severe. Early systems will suffer from low reliability (under 300 hours MTBF), modest resolution (525 TV lines), high operational costs, and replacement of oils, pumps, and CRT guns. The quality and reliability of light valve and related techniques will improve sufficiently by 1968 for these approaches to be price performance competitive with the slower film and photochromic projection displays, and should find almost exclusive use in the applications that require update times faster than one second.

F. Large Panel Systems

1. *Alphanumeric Panels*

a. *Electro-mechanical or magnetic panels* are individual digital readouts that are electro-mechanically changed from one displayed character to another. Most of these digital readouts are used as alphanumeric modules

such as counters, sequentially-rotating drums, totalizer devices. Electromagnetic readouts, on the other hand, permit character formation in about one millisecond. Electromechanical readouts are much slower, i.e., ten characters per second. Arranged in rows and columns, readouts serve the useful function of clearly visible display of 'fixed field' alphanumeric data such as airport flight panels, totalizers, directory systems, and computer generated messages.

b. *Optical-mechanical* are projection type readouts employing character selection matrices or 'lighted' segments to form the characters. Limited words also can be projected by a beam of light passing through each aperture to form the desired message. Slow speed automatic page composition devices also employ this optical-mechanical projection technique for automatic text preparation and photo-composition.

2. *Solid State Electroluminescent Panel Systems*

Electroluminescent (EL) systems permit direct conversion of elecrical energy into light within suitable phosphors. A typical EL device has a glass base to which is attached a transparent conductive film. A ceramic layer containing an EL phosphor separates the bottom conductor from the upper metallic film laid down in segments (7 for numerics; 14 for alphanumerics) that are used to form the digits. The individual segments glow when a voltage is applied – the problem is to provide selection of the segment to be activated.

The prices of the individual EL units with electronics, and problems such as switching and brightness, prohibit these systems from becoming price performance competitive within the next decade.

G. Advanced Displays

Electronic laser beam deflection promises to be the most significant advancement for post-1970 large-screen displays. Laser beam deflection will be employed with films, photochromics, and will also serve as a substitute addressing scheme for electrochemical and electroluminescent panels. Light addressing by laser beams promises to obsolete general X and Y matrix addressing and conventional high speed switching in the 1972-1975 period.

H. Price Performance Forecasts

Prices for 1963-1965 and 1968-1970 are given in Exhibit 4 for each of the seven classes of display capability presented in Exhibit 2. The seven classes of display capability serve as a key to relate these price performance forecasts to the industrial applications identified in Exhibit 3 supra.

Exhibit 4
DISPLAY PRICE PERFORMANCE TABLE

Display Capability*	System Prices (In Thousands of Dollars) 1963-1965	1968-1970
Class I	$12 - 20	$ 5 - 10
Class II	60 - 150	30 - 70
Class III	100 - 200	70 - 150
Class IV	200 - 1,000	150 - 300
Class V	200 - 300	100 - 200
Class VI	60 - 150	30 - 70
Class VII	150 - 250	90 - 150

*See Exhibit 2 for definitions of display capability.

I. Findings and Conclusions

1. Although commercial display application technology is in its infancy, substantial benefit will come in the

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next few years from the extensive use of displays in military command control applications which will rapidly upgrade applications know-how in the commercial management environment.
2. Visual display will provide one of the principal tools for the effective use of integrated data base which is rapidly becoming significant for on-line real-time systems.
3. Cathode ray tube technology will continue to be the heart of all general purpose display systems, both console and large-board type.
4. Recent advances in cathode ray tube technology will permit dramatic increases in the obtainable resolution and registration accuracy. This increase will be sufficient to permit a single tube CRT to be used to develop an entire 8½" x 11" page of information to be composed with lithographic quality, and hence permit not only improved internal operating reports to be produced, but also page composition for reports to the public and to stockholders.
5. Low-cost large-screen or wall displays will continue to employ light projection of a film recorded image from a cathode ray tube display subsystem, in many cases with a coordinated overlay from normal photographic film. The most successful applications of large displays in the next five to eight years will likely incorporate this mixture of film graphics with computer-generated information.
6. Sophisticated high resolution console displays will be largely cost-effective only when, in addition to the basic display function, the control computer can provide simultaneous design or evaluation computations, or perform the basic layout and hyphenation-justification for the photo-composition of senior management reports or documents for release external to the firm.
7. Reusable films, such as frosted thermoplastic and photochromic approaches, will substantially improve the cost effectiveness and ease of use of large-screen displays. These will become available in the 1968-1970 time period. Advance light valve projection systems will grow in importance as the principal means by which *dynamic* information displays are presented on a large screen. Film systems will achieve a dynamic response of a few seconds at most using rapid development techniques.
8. The price of the general purpose display console will decline from the present \$80,000-\$100,000 level to the \$40,000-\$60,000 price range by 1968-1970 — representing a 2:1 price decrease.
9. The ability to display several colors will continue to be substantially more expensive (20-30 per cent minimum) and somewhat slower than black and white displays.
10. It is forecast that electroluminescent panels will not become price performance competitive with other large-screen displays, if at all, until well after 1972 because of problems of switching, brightness and cost.
11. Individual alphanumeric readout modules will retain their utility for fixed field information display, although it is unlikely that there will be significant price reduction before 1968 at which time a 2:1 decrease should be obtainable in the price of these modules.
12. Post 1970, both light valve and film projection systems will be challenged by electronically deflected laser beam display techniques employing solid state electrochemical or electroluminescent display panels.

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PRESENTS THE BIG PICTURE IN MANY WAYS, ANY COLOR

A Real Time Display for a wide range of applications— from alphanumeric readout to master plotting-board display — the OSCILLOSCOPE 290 is the ultimate in big-screen oscilloscope projection for both large and small groups. In either direct or rear-view projection, the OSCILLOSCOPE 290's needle-sharp picture presents the facts with the clarity and brilliance required by the most critical of audiences.

The OSCILLOSCOPE 290 may be used over a wide variety of subjects including: alphanumeric displays for computer read-out . . . combat information-center displays . . . master plotting board displays . . . basic training in electronic wave forms . . . projection of airline schedules . . . radar target acquisition . . . aircraft position plotting for control-tower operators, etc.

The DALTO PROJECTION OSCILLOSCOPE 290 combines high brightness and resolution with wideband linear deflection amplifiers to provide top quality images capable of filling a 12 foot screen.

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Society for Information Display

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ID Products

Fiber Optic Faceplate CRTs

Two new cathode ray tubes with fiber optic faceplates for making photographic reproductions of their outputs are available from Westinghouse Electronic Tube Div.

One of the tubes, type WX-30038, has a four-inch-diameter fiber optics faceplate. The usable screen has a diameter of 3.2 inches. This tube uses magnetic deflection and electrostatic focusing.

Second tube, type WX-5321, is designed for line scanning. Over-all diameter of the face is 5¼ inches. A band of optical fibers across the center of the faceplate has a usable length of 4¼ inches and width of ¼ inch.

Write Richard Rees, Mktg. Mgr., Westinghouse Electronic Tube Div., Elmira, N.Y., phone 607-739-3611.

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New Data Display System

Telemetrics 801 Data Display System features real time, real language display with universal flexibility based on programmed inputs. Off-line operation is achieved by internal memory.

System provides visual monitoring, easy interpreting of information and permits playback of stored data in real time presentation. The 801 displays any one of 12 pages or levels of information, each with 12 lines and up to 32 characters per line, on 23-inch rect. CRT. Display scope may be operated as part of the main console or removed for remote operation.

Data sheets and details available from David Lang, VP-Marketing, Telemetrics Inc., 2830 S. Fairview St., Santa Ana, Calif. or phone (714) 546-4500.

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Miniature Yoke

Miniature encapsulated precision yoke with deflection angle up to 70° is available for ⅜" to 1" neck diameter CRT's. The Type Y65, in either a push-pull or single-ended configuration, is designed for a wide variety of small neck tube applications such as flood gun storage tubes, small compact displays and data displays. It can be furnished in a wide range of impedances for both transistor drivers and vacuum tube circuits. Electrically balanced windings provide equal deflection sensitivities.

Contact Henry Marcy, Sales Manager, Syntronic Instruments, 100 Industrial Road, Addison, Illinois.

Circle Reader Service Card No. 11

Readout Driver with Memory

Binary-coded-decimal to decimal decorder readout driver with memory is now available from Burroughs Electronic Components Div. In this device flip-flops have been replaced by silicon controlled switch latches. In a typical readout memory, this means elimination of almost 100 components.

For detailed information, write Burroughs Corp., John Turnbull, Sales Manager Electronic Components Div., Plainfield, New Jersey.

Circle Reader Service Card No. 12

New Data Recorder System

DATASTAT system, self-contained Monitor/Camera/Processor/Printer records transient data from TV or CRT presentations of all types including character generation and produces 8½ x 11 electrostatic hard copies. Print quality is high and either continuous tone or line copy may be produced, depending on the type of data being recorded.

DATASTAT accepts input data at any rate up to 6 frames per second. The first hard copy print is produced within 30 seconds and succeeding frames are produced every five seconds.

Contact Carl J. Brasser, VP-Mktg., Photomechanisms, 15 Stepar Place, Huntington Station, N.Y.

Circle Reader Service Card No. 13

Oil Tight Indicator Lights

These indicator lights achieve complete seal on face of the panel by three retained elastomer seals of inert material — gasket and two "O" rings. Gasket is used in assembly of lens into its metal holder, making permanent seal. First "O" ring, which is retained, makes closure when cap screws on bushing. Second "O" ring, also retained, makes the seal of bushing to panel surface.

This feature is embodied in new line UL and CSA listed indicator lights.

Write H. W. Goodman, Sales Manager, Dialight Corp., 60 Stewart Avenue, Brooklyn, N.Y.

Circle Reader Service Card No. 14

Miniature Logic-Lites

These miniaturized Logic-Lites incorporate transistor driver circuits or other networks within the packaged lamp unit. This eliminates signal loading and removes relatively high currents required from sensitive logic elements in equipment. Most models are ½ inch in overall diameter and mount in ⅜ inch holes.

Standard circuits are available to meet most application requirements and special units are developed quickly with either neon or incandescent lamps. Choice of terminal types, many lens colors and shapes, and a number of lamp configurations are standard features.

For data write: Tim Moore, Sales Manager, Eldema Corp., 1805 Belcroft Ave., El Monte, Calif.

Circle Reader Service Card No. 15

New Binary Codes Catalog

Two-color catalog just published contains 4 pages of truth tables, grouped by switch types, for binary codes available from Chicago Dynamic Industries, Inc., Precision Products Div., 1725 Diversey Blvd., Chicago, Illinois 60614. Phone (312) WE 5-4600. Please send inquiries to J. C. Koci, general manager.

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The best Deflection Yoke for your display is the one that meets your total system requirements, at the lowest cost, delivered on time. For most displays you can select that best yoke directly from the CELCO Display Engineering Manual.

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ID Authors

F. W. Jenison, Jr. (left).
A Senior Systems Analyst in the Financial Applications area, Mr. Jenison has been with the Bunker-Ramo Corporation since 1961. He is responsible for systems support to the American Stock Exchange. Previously, he was associated with DuPont and Univac.

Emik A. Avakian (right).
Supervisor of the Man-Machine Interface Group in the Advanced Systems Development Dept., Mr. Avakian has been with Bunker-Ramo since 1957. He holds several patents in the ID field and co-invented the audio response system described herein. He is a member of SID.

Peter James (left).

Mr. James is Associate Director, Defense Information Systems, The Diebold Group, Inc. He founded a firm manufacturing remote controlled total information display systems for bowling scores. He previously worked for IBM. He holds L.L.B. and B.S. degrees and belongs to SID.

D. L. Dittberner (right).
Currently Director, Diebold Research Program, Mr. Dittberner is studying information technology developments through the early 1970's for many of his firm's clients. Previously, he held several positions with IBM and was a consultant to government and industry.

Albert S. Goldstein

A Research Engineer in JPL's Systems Division at Cal Tech, Mr. Goldstein has worked for two years on display technology for use in his firm's Space Flight Operations Facility. He previously worked for GE and Sperry Gyroscope Co. He has an M.S. degree in Systems Engineering.

EDITORIAL ADVISORY BOARD

A technical Society journal is always a difficult publication for which to provide meaningful editorial material. Within an interdisciplinary field such as information display may be found specialists ranging from psychologists to electronc engineers, psychophysicists, equipment designers, systems analysts, optical and solid-state physicists and engineers. Obviously, there must be an underlying thread of common interest in such a diverse assemblage of disciplines, yet there is also a basic difference in academic training, problem approach, and terminology.

In order to establish and maintain a dynamic editorial policy, a distinguished team of consultants has been brought together to form the Editorial Advisory Board for **Information Display**, the Official Journal of the **Society for Information Display.** By means of this Board, the SID will be assured of continuing review at the highest professional level of papers to be published and areas to be covered.

Members of the Editorial Advisory Board represent the dominant disciplines active in the field of information display, both in private industry and in government agencies. Some were introduced in the inaugural issue of **Information Display;** three additional distinguished members of **ID's** Editorial Advisory Board are presented below.

Mr. Theodore Hamburger

At present, Mr. Hamburger is affiliated with Westinghouse Corp. He has been project engineer on a number of solid state systems including ferro resonant and ferroelectric elecroluminescent displays, lightweight radar circuitry, solid state radar modulators and micro-electronic programs.

Mr. Hamburger received a B.E.E. from CCNY and an M.E.E. from Brooklyn Polytechnic Institute. At Microwave Research Institute he did design and development work on junction and point contact transistor circuitry, negative impedance, and microwave calorimetry. During two years of Army service he was stationed at the Army Chemical Center and developed timing circuitry and electro-mechanical systems for high speed photography.

Among papers Mr. Hamburger has published are several on electroluminescence as applicable to the field of information display. He is a member of IEEE, Sigma Xi, Tau Beta Pi, Eta Kappa Nu, and SID. He is also a registered Professional Engineer in the state of Maryland.

Mr. William Paul Bethke

Director of Engineering at Rome Air Development Center, Griffiss AFB, Rome, N.Y. for the past four years, Mr. Bethke has worked at Rome ADC since 1952. He joined the Base that year as Staff Engineer, Plans and Operations Office, following an affiliation as Project Engineer at Watson Laboratories in Eatontown, N.J.

Mr. Bethke was born in Milwaukee, Minn., on April 22, 1920. He received a B.S.E.E. from Marquette University in 1942 and did post-graduate work at Illinois Institute of Technology. He served with the U.S. Army from 1942-1946.

Chairman of RADC's Scientific and Professional Committee, Mr. Bethke is also Chairman of the Vocational Advisory Board for the Board of Education at Rome, N.Y. and Chairman of the IEEE's Mohawk Valley Section.

An active member and Northeast Regional Director of SID, Mr. Bethke also serves as Chairman of SID's Definitions and Standards Committee. He has authored several reports on ground navigational aids and display techniques.

Dr. Edith M. Bairdain

Dr. Edith Bairdain is currently Supervisor of the Command and Control Personnel Subsystem Section of the ITT Data & Information Systems Division.

Included in her professional responsibilities are systems analysis, development of design criteria and operational requirements, and direction of human factors studies for large-scale information processing and display systems. Additional experience during the past few years has involved activity in the area of group interaction, human perception, and learning.

Prior to her current affiliation, Dr. Bairdain was Project Director in group development research at Columbia University in N. Y. and a consultant to several governmental and industrial agencies.

Dr. Bairdain received B.S. and M.A. degrees from Columbia University. She was awarded a Ph.D. degree from Emory University.

A charter member of SID, Dr. Bairdain is also a member of the American Psychological Assn., Eastern Psychological Assn., and the Human Factors Society.

NANOSECOND PULSE FROM NEW RAULAND ULTRAFAST SCAN CONVERTER STORAGE TUBE

Photograph of a 24 nanosecond transient pulse as displayed on an ordinary television monitor.

Rauland has developed an ultrafast Scan Converter Storage Tube that records and stores transient phenomenon with pulse rise times in the range of a nanosecond or less. The unique design of the new Rauland R6253 tube permits slow scanning techniques to be used for the relay of transient pulse data over narrow band systems of 100 KC bandwidth or less. The pulse may also be recorded by conventional means—on magnetic tape, transmitted over inexpensive telemetry links, over communication cables, displayed on an ordinary television monitor and photographed using "box camera" exposure time. When displayed on a monitor, the tube further allows unaided visual observation of extremely fast phenomenon for a period of several seconds. Relay or recording of pulses can be simultaneous with visual observation. The tube, consisting of separate writing and reading electron guns, is approximately 27 inches long and is 4 inches at its largest diameter. It utilizes a distributed deflection system for the writing side and either magnetic or electrostatic deflection for readout of high speed phenomenon. The tube is available with characteristic impedances of 50 or 125 ohms. The deflection system, being a continuous transmission line, allows the operation of several tubes in series.

SCAN CONVERTER STORAGE TUBES

Resolution Capability of 1000 TV lines. Erase Capability of 2 seconds or less. Any combination of electrostatic or magnetic deflection is available.

FLAT FACE DISPLAY TUBES

Rauland's flat face tubes (16", 22", 24") minimize parallax error. Resolution capability of 1000 TV lines at a brightness of 100 foot-lamberts. We will suit your specific requirements with any type of radar display tube in any size with any type phosphor or gun.

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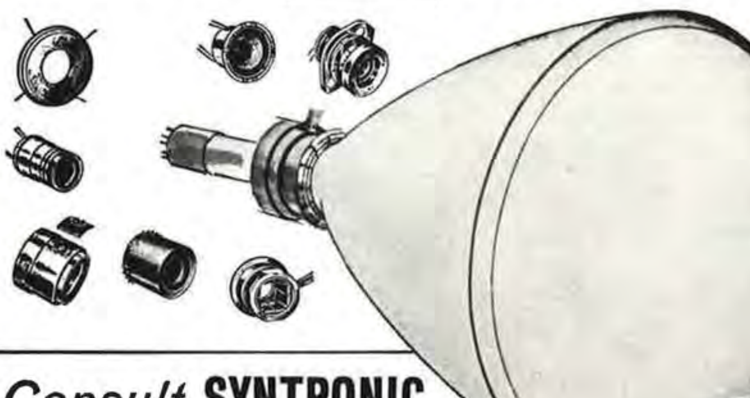

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LAST CALL FOR PAPERS

Due to a number of requests, the date for submission of abstracts of papers for the Fifth National Symposium on Information Display has been extended to 22 December 1964. The Symposium will take place at the Hotel Miramar, Santa Monica on February 25 and 26, 1965.

Please submit 500 word abstracts in duplicate to:

R. L. KUEHN
Papers Chairman
P. O. Box 63
Duarte, California 91010

As a special feature, the Convention Committee has established a prize of a $100 U.S. Savings Bond for the best paper at the Symposium.

REPORT CARD

NAME 801 Data Display System

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SUBJECT	COMMENTS	GRADE
Reading	Reads and accepts digital inputs in parallel form at a selected or programmed up-date rate.	A
Writing	Most flexible in its class; uses beam-pencil to write 12 "pages" or levels of information each with 12 lines of data at 32 characters per line.	A
Arithmetic	Memorizes and handles large masses of any kind of data (does not really perform computations as such).	A+
English	Uses real language, not wiggly lines; very easy to see, analyze, or filter processed data.	A+
History	Repeats itself every 16 milliseconds; uses own buffer memory to up-date data.	A
Science	Performs well in any area of investigation, industrial research, experimentation, or process control.	A

ELECTIVES

SUBJECT	COMMENTS	GRADE
Art	Draws maps, charts, graphs, curves, etc.	A
Shorthand	Abbreviates as required by the programming.	A
Economics	Considerably less expensive to operate and maintain than a family of strip-chart recorders.	A+

PERSONAL

Work Effort - Capable of very hard real-time work when asked; applies own buffer memory and character generation memory to reduce the work load on any computer by a factor of 20,000; will work in an off-line situation.

Cooperation - Plays well with the Telemetrics 670 Data Processing System, but will also play with any general purpose computer when so instructed; will not interfere with the playing of permanent read-out devices.

Application - Shows strong tendency to replace as many as 4,608 conventional single-character read-out devices at one time; is also capable of one or more remote displays.

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